

Technical Manual

No. 5-689

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
Washington, DC, 10 September 2001

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED
--

## ADP/Computer Electrical Installation and Inspection for Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Facilities

		<i>Paragraph</i>	<i>Page</i>
CHAPTER 1.	INTRODUCTION		
	Purpose	1-1	1-1
	Scope	1-2	1-1
	References	1-3	1-1
CHAPTER 2.	FACILITY POWER SYSTEM		
	Dependable power system requirements	2-1	2-1
	Commercial (utility) power	2-2	2-3
	Power line phenomena	2-3	2-4
	Power quality requirements	2-4	2-6
	Power quality parameters	2-5	2-7
	Detection of power line anomalies	2-6	2-8
CHAPTER 3.	POWER CONDITIONING		
	Automated data processing power requirements	3-1	3-1
	Power line disturbances	3-2	3-2
	Acceptable limits for ac power	3-3	3-4
	ADP protective equipment	3-4	3-5
	Power distribution systems	3-5	3-15
CHAPTER 4.	GROUNDING		
	Purpose of grounding	4-1	4-1
	National electrical code (NEC) requirements for grounding	4-2	4-1
	System configurations	4-3	4-4
	Ground configurations	4-4	4-9
	Grounding for fault protection	4-5	4-10
	ADP grounding	4-6	4-16
CHAPTER 5.	HARMONICS		
	Harmonics defined	5-1	5-1
	Harmonic sources	5-2	5-1
	Harmonic technical history	5-3	5-2

	<i>Paragraph</i>	<i>Page</i>
Resonance	5-4	5-3
Electrical loads	5-5	5-4
Neutral currents	5-6	5-5
Derating power equipment	5-7	5-6
Generator control problems	5-8	5-7
UPS output harmonic distortion	5-9	5-8
AC system response to harmonics	5-10	5-8
Solution of harmonic problems	5-11	5-11
Measurement of non-sinusoidal currents and voltages	5-12	5-16
Conclusions	5-13	5-17
 CHAPTER 6.		
STANDBY POWER		
Introduction	6-1	6-1
Codes and standards	6-2	6-3
Off-line/on-line ADP systems standby power requirements	6-3	6-3
Diesel generator standby systems	6-4	6-5
Battery standby systems	6-5	6-8
Transfer switches for standby systems	6-6	6-20
Grounding standby power systems	6-7	6-30
 CHAPTER 7.		
LIGHTNING		
Lightning effects on power systems	7-1	7-1
Principals of protection	7-2	7-4
Lightning protection systems	7-3	7-5
 CHAPTER 8.		
INSTALLATION		
Objective of an automated data processing (ADP) system	8-1	8-1
Contract bidding	8-2	8-1
Inspection requirements	8-3	8-2
Ground system installation inspections	8-4	8-3
Neutral junction installation inspections	8-5	8-4
Safety ground installation inspections	8-6	8-4
Inspecting for unbalanced loads	8-7	8-6
Utility power system installation inspections	8-8	8-6
RFI inspections	8-9	8-7
ESD inspection	8-10	8-9
ADP system environment inspections	8-11	8-10
Pre-site inspection	8-12	8-12
Pre-inspection for electrical systems	8-13	8-12
ADP room inspection	8-14	8-13
Air-conditioning system inspection	8-15	8-13
Lighting system inspection	8-16	8-14
Fire safety inspection	8-17	8-14
Total evaluation	8-18	8-14
 CHAPTER 9.		
MAINTENANCE		
Objective	9-1	9-1
Maintenance program	9-2	9-2
Maintenance data file	9-3	9-4
Personnel qualifications	9-4	9-5

	<i>Paragraph</i>	<i>Page</i>
Dedicated maintenance equipment	9-5	9-6
Renewal parts	9-6	9-7
Continuous inspection program	9-7	9-8
Maintenance schedule	9-8	9-8
Maintenance tests	9-9	9-9
Safety	9-10	9-10
Electrical equipment fires	9-11	9-12
Equipment diagrams	9-12	9-12
Test forms	9-13	9-13
APPENDIX A. REFERENCES		A-1
APPENDIX B. ITI (CBEMA) CURVE APPLICATION NOTE		B-1
GLOSSARY		G-1

## LIST OF FIGURES

<i>Figure</i>	<i>Title</i>	<i>Page</i>
Figure 4-1	Minimum grounding requirements for ac powered isolated system	4-5
Figure 4-2	Minimum grounding requirements for battery powered isolation system	4-6
Figure 4-3	Clustered system	4-6
Figure 4-4	Basic grounding of a clustered system	4-7
Figure 4-5	Central-with-extensions system	4-9
Figure 4-6	Single phase 115/230 Vac power system ground connections	4-13
Figure 4-7	Three phase 120/208 Vac power system ground connections	4-13
Figure 4-8	Properly wired ac distribution circuits for minimum ground noise	4-14
Figure 4-9	Noise problems resulting from improper wiring	4-15
Figure 5-1	Series RLC circuit	5-10
Figure 5-2	Poles and zeros on the s-plane	5-11
Figure 5-3	Surface view of H(s) for all complex frequency in s-plane	5-12
Figure 5-4	Response vs frequency for steady state input	5-12
Figure 5-5	Phase angle and power factor vs frequency	5-13
Figure 5-6	Impedance vs frequency	5-13
Figure 5-7	Tuned passive filter	5-14
Figure 5-8	Impedance poles and zeros of tuned passive filter	5-15
Figure 5-9	Tuned passive filter with static Var control	5-15
Figure 5-10	Active load current compensation	5-16

## LIST OF TABLES

<i>Table</i>	<i>Title</i>	<i>Page</i>
Table 4-1	Summary of the effects of shock	4-11
Table 5-1	Voltage distortion limits for medium and high voltage power systems	5-2
Table 6-1	Typical range of input power quality and load parameters of major computer manufacturers	6-2
Table 6-2	Comparison of cells required for NICAD and lead acid batteries	6-19